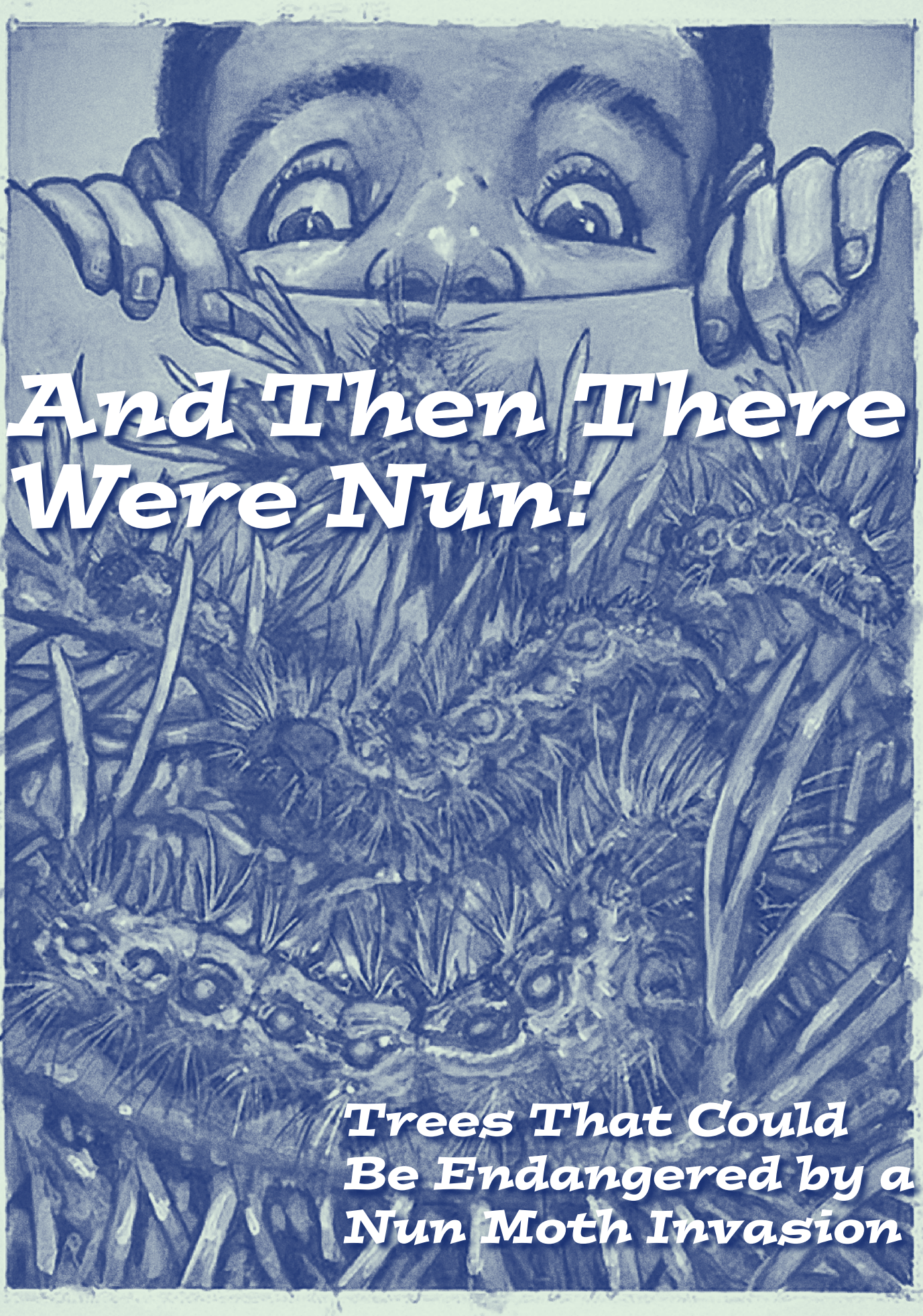


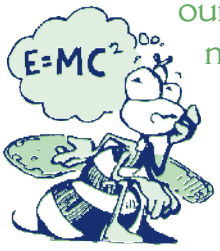
And Then There Were Nun:

Trees That Could Be Endangered by a Nun Moth Invasion

Meet the Scientist

Dr. Keena: ▼ My favorite science experience is when the mysteries of insect biology or behavior are ultimately unraveled at the end of a study.

Thinking About Science



In today's world, we often think about our Nation's security. There are many different types of threats to our Nation, including biological threats from *nonnative* animal and plant *species*. In this research, the scientist studied a species of moth that has not yet been found in the United States. In Europe and Asia, this moth has done much damage to trees. The scientist wanted to know what tree species in the United States would be damaged if the moth were to come into the country.

To do her study, the scientist brought the moth eggs to the United States. When she did her experiments, she had to be certain the eggs, *larvae*, or moths did not escape into the natural environment. When scientists work with dangerous *organisms*, they must use extreme care to make sure their experiments are totally secure.

Glossary:

nonnative (nän **na** tiv): Not naturally occurring in an area.

species (**spe** sez): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

larva (**lär** vuh): Wormlike feeding form that hatches from the egg of many insects. Larvae (**lär** ve) is the plural.

organism (**ôr** gä niz um): Any living thing.

ancestor (**an** ses tür): An early kind of animal from which later kinds have developed.

characteristic (**ker** ik tür is tik): The special character or trait of some person or thing.

habitat (**hab** uh tat): Environment where a plant or animal naturally grows and lives.

conifer (**kä** na für): A type of evergreen tree (pine, fir, spruce) that has cones.

broadleaf (**brôd** lef): Flat broad leaves.

crevice (**kre** vis): A narrow opening caused by a crack or a split.

incubate (**i*ng*** kyu bat): To keep something warm and protected so it will hatch.

pupa (**pu** pa): Intermediate stage of insect growth between larva and adult. Pupae (**pu** pe) is the plural.

native (**na** tiv): Naturally occurring in an area.

foliage (**fo** le uj): The leaves of a tree or plant.

economic (e ko **nom** ik): Having to do with managing money and resources in a home, business, or government.

Pronunciation Guide

a	as in ape	o	as in go	ü	as in fur
ä	as in car	ô	as in for	oo	as in tool
e	as in me	u	as in use	*ng*	as in sing
i	as in ice				

Accented syllables are in **bold.**

Thinking About the Environment

Over a period of hundreds or thousands of years, organisms adapt to survive in their environment. Often, similar species living in different areas have adapted from a common *ancestor*. They may share many *characteristics*, but because they have adapted to different environments, they may also have different characteristics.

In this study, the scientist examined the preferred reproductive *habitat* of a certain type of moth. In Europe and Asia, this moth prefers to lay her eggs in particular tree species. When the eggs are laid and the larvae hatch, the larvae eat the leaves as they grow and develop. Eating the leaves damages the tree and may even kill it. The scientist wanted to know which tree species in the United States would be the preferred reproductive habitat for this moth, if it were to invade.

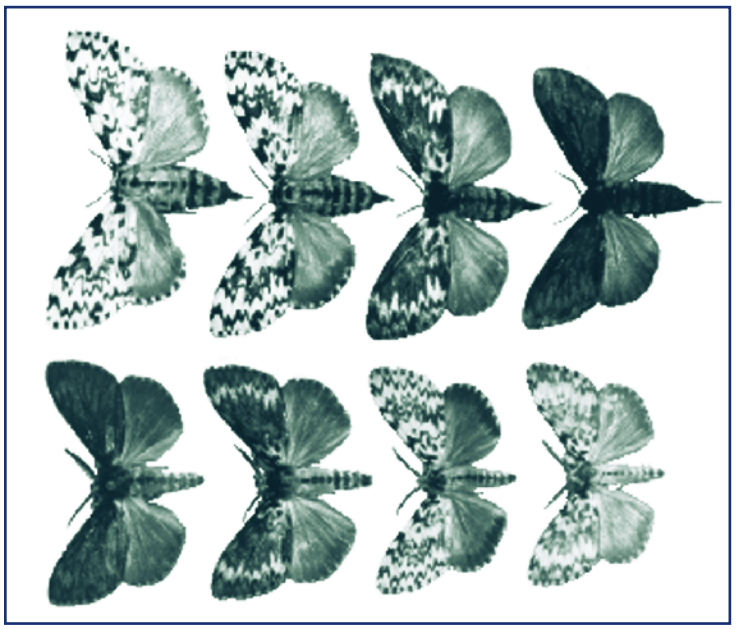


Figure 1. Nun moths.

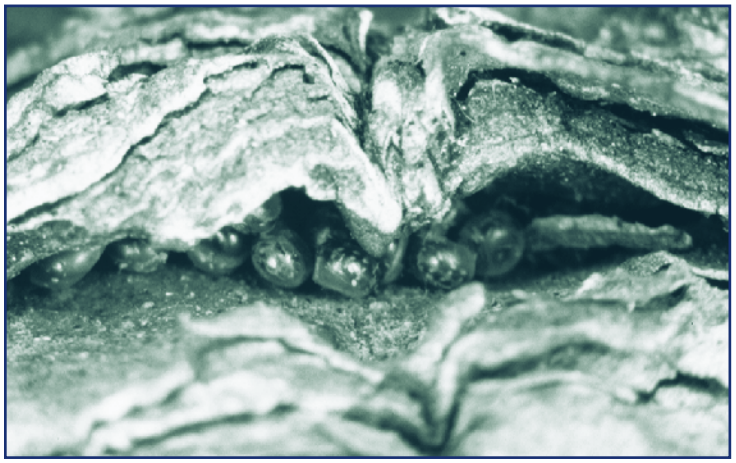


Figure 2. Nun moth eggs in the crevices of tree bark.

Introduction

The nun moth is a major pest of *conifers* and an occasional pest of *broadleaf* trees in Europe and Asia (**figure 1**). If the moth were to come to the United States, it might be a pest in the United States as well. So far, the nun moth has not been found in the United States. Insects like moths can be transported from country to country in or on the containers or vehicles that hold the goods that countries trade. For example, you might notice that your shoes were made in another country. Your shoes might have been shipped with hundreds of shoes in wooden crates when they were sent from that country to the United States.

The nun moth lays her eggs in the *crevices* of tree bark (**figure 2**). Think about what might happen if just one nun moth laid her eggs in the crevices of wooden crates that were shipped to another country. This is one way invasive species move from country to country. If the nun moth eggs or larvae were to come into the United States, they might find trees that are favorable to their growth. This situation could threaten the health of those trees and the forests they grow in.

We hope the nun moth will never invade the United States. If it does, however, it would be helpful to know which tree species would be most at risk. The scientist in this study wanted to discover which trees in the United States would be the preferred habitat of nun moths.

Reflection Section

- In your own words, state the question the scientist wanted to answer.
- What is the advantage of knowing in advance which tree species might be the preferred habitat of the nun moth?
- The scientist did this study in the Northeastern United States. Do you think she studied the moths inside or outside a laboratory? Explain your answer.

Method

The scientist used eggs that came from Eastern Europe (**figure 3**). She *incubated* the eggs (**figure 4**), which caused them to hatch into larvae (**figure 5**). She divided the larvae into two groups. The scientist observed the first group of larvae for the first 14 days of their development. She observed the second group of larvae through their development into *pupae*.

Figure 3. Eastern Europe.

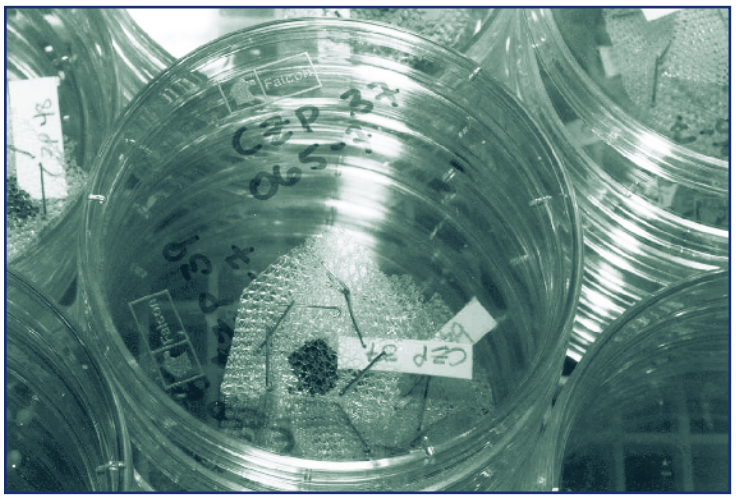


Figure 4. Nun moth eggs being incubated in a mesh packet. You can see the mesh packet and eggs inside the petri dish.

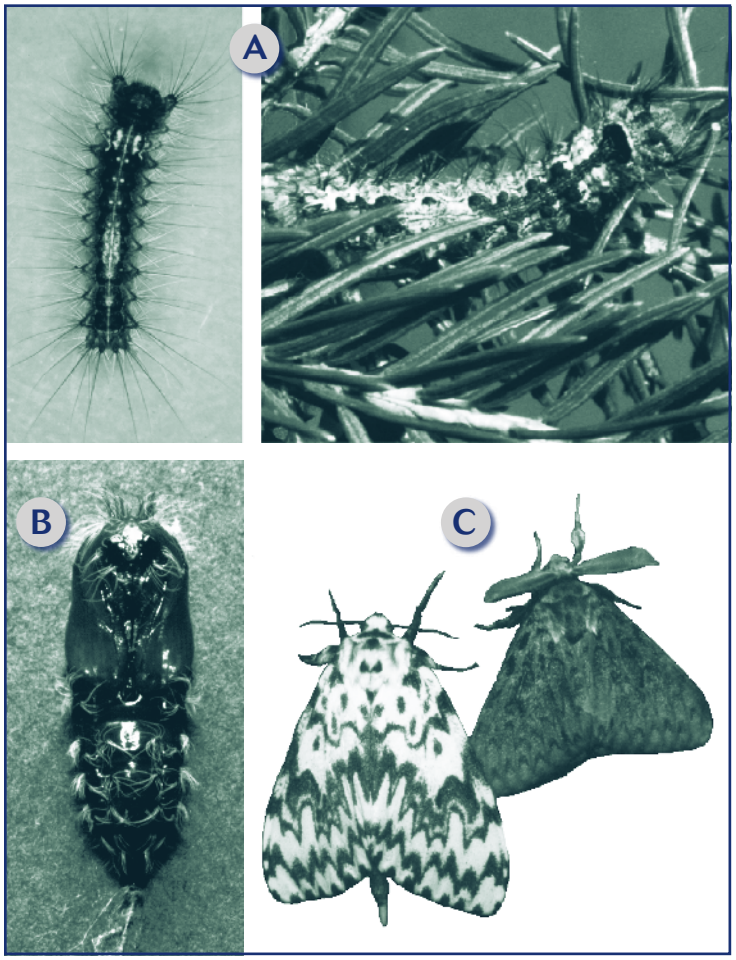


Figure 5. The life cycle of the nun moth. The eggs are shown in figure 2. Here, you can see the larva (5a), pupa (5b), and adult nun moth (5c).

Within each of the two large groups, the scientist further separated the larvae into groups of 30. She allowed each group of 30 to feed on one particular tree species. The scientist used 26 tree species that are *native* to the United States and 8 tree species native to Europe or Asia. The larvae that were observed until they became pupae were allowed to feed on trees native to the United States. They also were allowed to feed on their two favorite European trees for comparison.

For each group of 30 larvae, the scientist used a container to hold the larvae. She placed the *foliage* from one tree species into a cup with water, and then placed the cup with the foliage in a container with the larvae. She covered each container with clear plastic to allow light to enter (**figures 6a and 6b**).

Because the foliage needed to remain fresh, the scientist periodically placed new foliage in the containers. Each time she changed the foliage, the scientist removed all contents of the container. She counted the number of live and dead larvae and recorded her observations. She also observed and recorded what species of foliage the larvae were eating. When the scientist put fresh foliage into the container, she placed the remaining live larvae back into the container with the fresh foliage.

Figures 6a and 6b. Containers that held larvae and foliage. There were 34 different containers, each with a different species of foliage and 30 larvae.

At the end of 14 days, the scientist removed the first group of larvae from its containers. For each container, the scientist counted the number of larvae still alive and calculated the percentage that had survived 14 days.

Number Crunches

- How was the percentage of surviving larvae calculated?

Remember that larvae from the second large group were allowed to develop into pupae. For this group, the scientist counted and recorded any pupae that had developed from larvae and then removed them from the container. Removing the pupae left only larvae in each container. The scientist removed the pupae each time she changed the foliage. She continued to do this until all the larvae should have developed into pupae, which was a total of 70 days. She then counted and recorded the number of larvae that did not develop into pupae. From this number she was able to calculate the overall percentage of larvae becoming pupae in each container.

Number Crunches

- How did the scientist calculate the percentage of larvae that had become pupae?

Reflection Section

- What did this experiment enable the scientist to discover?
- When the scientist placed fresh foliage in each container, do you think she used the same species of foliage that she had removed from that container? Why or why not?
- Why do you think the scientist wanted to discover what percentage of larvae became pupae?

Findings

The scientist compared the percentages of surviving larvae and pupae for each of the 34 types of foliage. Basing her calculations on this comparison, she rated each of the tree species as being suitable, intermediate in suitability, or poor in suitability for nun moth development. For species rated suitable, few additional larvae died after living for 14 days. The larvae ate the foliage of every conifer species. For most of the conifer species, the larvae preferred to eat the young foliage that had just emerged. Foliage that had grown in previous years was not eaten by most of the larvae until they had reached an older stage of development (**figure 7**).

The results were mixed for the broadleaf species. Some of the broadleaf species were not eaten at all. The larvae did not want to eat the small young reddish leaves of the white oak tree, but when the young leaves turned green, the larvae devoured them (**figures 8a and 8b**). The larvae also ate the foliage of gray birch, American beech, black oak, northern red oak, and California white oak. They also ate the flowers of wild cherry trees.

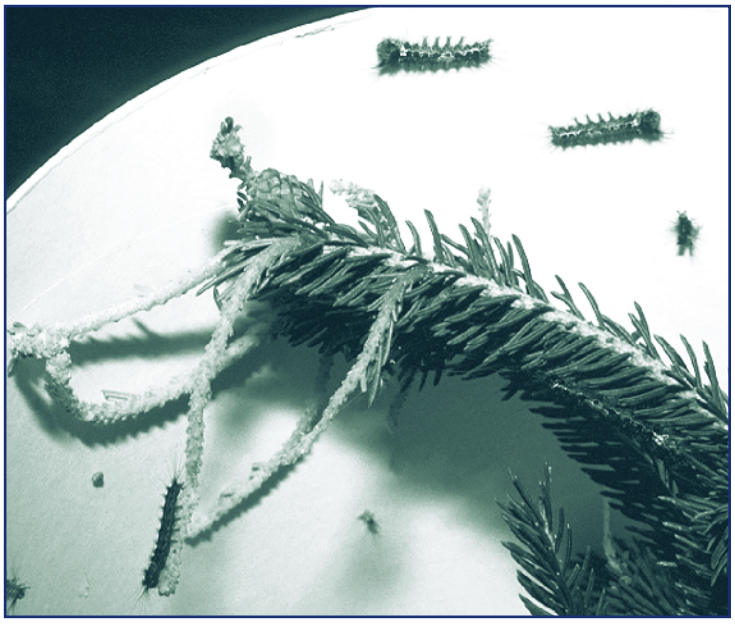


Figure 7. The larvae ate the young needles of the Norway spruce first. You can see they did not eat the older needles.

Figure 8a. The newly unfolded reddish leaves of the white oak were not eaten by the larvae.

Figure 8b. After the reddish white oak leaves turned green, they became a favorite meal of nun moth larvae.

Reflection Section

- What species of trees do nun moth larvae prefer to eat?
- Do you think these findings are good news or bad news for people worried about the invasion of nun moths into the United States? Why?

Doing Research on Dangerous Insect Pests

Scientists at the U.S. Department of Agriculture (USDA) Forest Service use a secure laboratory to conduct research with insect pests such as the nun moth. The building is locked and has an alarm system. When scientists enter the building, they must change into special suits that they wear only inside the laboratory. The laboratory has no windows, and the exhaust system has very fine mesh through which no insect can escape.

Within the laboratory, scientists handle all insects inside safety cabinets, which further prevents escape. These cabinets also protect the scientists from the insects. After the scientists finish the experiments, they kill all insects and sterilize their remains before putting them into special bags. Later, specialists will burn these bags, passing the exhaust through filters. This special laboratory enables USDA Forest Service scientists to learn about insect pests without endangering people or the environment.

Discussion

If the nun moth were to invade the United States, it could cause a lot of problems for trees, forests, and people. The forests most likely to be affected are those in the Northwestern United States, the upper Midwestern United States, and the Northeastern United States. Many of the tree species preferred by nun moth larvae are *economically* important, and their damage or loss could affect people working in the forest industry. ■

Reflection Section

- Trees are important to people in forest industries, such as those using trees for wood products. Many industries that depend on forests might need the trees alive and healthy. What other forest-dependent industries could be affected by a nun moth invasion?
- In addition to economic problems, what other kind of problems might be created by the damage or loss of a large number of trees in a forest?
- What is one way we can protect trees in the United States from a possible nun moth invasion?

From: Keena, M.A. 2003. Survival and development of *Lymantria monacha* (Lepidoptera: Lymantriidae) on North American and introduced Eurasian tree species. *Journal of Economic Entomology.* 96(1): 43–52.

FACTivity

In this FACTivity, you will use the findings from this study to draw a conclusion about the possible danger from a nun moth invasion. You will answer the following question:

Could nun moths damage trees growing in your area?

You will use the following method to answer this question:

1. Reread the "Findings" section of this article. Make a list of the types of trees nun moths like to eat.
2. Consult a guidebook to learn which trees can be found in your area. You can find books in the library or you can find this information on the Web. Usually, guidebooks will present the trees that grow in a large area, such as the Southeastern United States, or the Great Lakes area. Using the list you made in #1, identify which trees, if any, are growing in your area that the nun moth may want to eat. Do not forget that, according to this article, the nun moth likes all conifer trees.
3. Make a list of the trees growing in your area that a nun moth might like to eat.
4. Basing your conclusion on the list you made in #3, what would you conclude about the potential impact of the nun moth if it were to invade in your area?
5. Hold a class discussion about the potential impact of the nun moth in your area. Basing your thoughts on this discussion, do you think it is important to protect the United States from a possible nun moth invasion? Why or why not?

Activity extension:

Make an inventory of the trees growing in your schoolyard. If the nun moth were to invade in your schoolyard, what kind of effect would it have? How would your schoolyard look different?

If you are a Project Learning Tree-trained educator, you may use PLT Pre K–8th Activity Guide #40, "Then and Now," and Activity Guide #3, "Peppermint Beetle," as additional activity resources. These activities teach what happens when a nonnative species is introduced and how insects use their sense of smell to find food and mates.